Pile-up simulation philosophy

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Basic idea for LAr analysis

- Have separate data streams
  - Rock events
  - ND-LAr
  - Rest of ND hall
- Run GENIE + G4 + detector simulation separately for each of these
- Output is TTree with hit voxels in ND-LAr → you have 3 sets of trees
- One entry is one neutrino interaction, no pile-up has been done at this stage

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Adding in pile-up

- Pile-up should be added just before reconstruction

- Figure out the mean number of events per spill that come from each sample from POT

- Poisson fluctuate the number of events from each

- Add them together, picking event time from the beam spill histogram and shifting every hit time by that amount

- Do your reconstruction

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Advantages

- All of the production up to reconstruction is independent of intensity – we can use the same files for 0.5 MW and 1.2 MW and 2.4 MW

- Some events aren't very important, and you generate less POT in those volumes and reuse events

  - For LAr analysis, LAr and cryostat events are common, and you don't want to reuse them

  - Rock events mostly make muons that aren't that unique, and you can probably reuse the same few thousand rock muons over and over

  - Interactions in SAND and ND-GAr rarely hit the detector, and you can reuse them – generating equal POT on these volumes is expensive

- Disk usage is reduced by not having large samples of edep-sim output files with spills of different intensities

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Disadvantages

- Requires that the analyzer think about what events matter and what events don't, and opens the possibility of accidentally omitting an important background

- Possible code duplication of the overlaying tool itself

- If the reconstruction is very slow compared to GENIE + G4 + det sim, it might not save very much time

- Will not properly account for actual 3D pile-up, where drift might be impacted by the presence of another event, but I think this is negligible

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Mixing is analysis specific

- LAr analyses can ignore SAND, but SAND analyses can't ignore LAr

- GAr analysis probably requires dedicated FV sample to get enough rate on gas

- A good idea would be to think of all of the different events that affect each analysis, and generate them in as few samples as possible

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7 samples

- Near rock (few m upstream of hall)
- Far rock (everything else)
- ND-LAr whole system
- GAr fiducial
- Rest of ND-GAr system
- SAND without the tracker
- SAND tracker only

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